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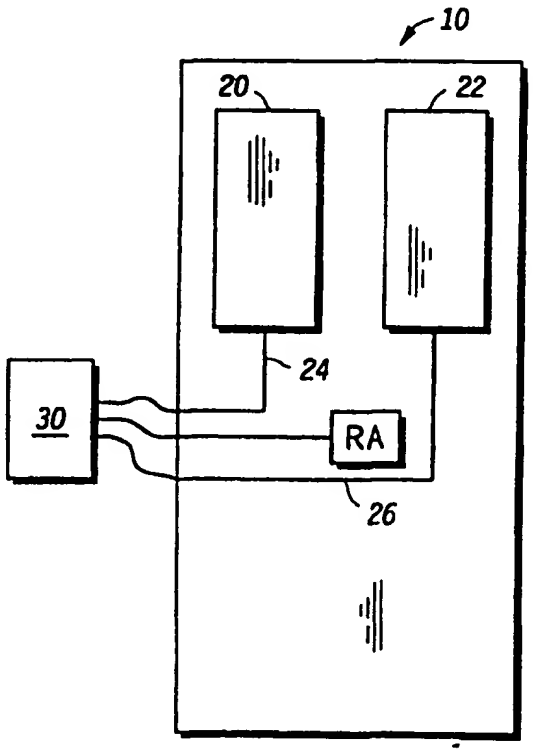
(54) Title: TRANSPARENT ELECTROSTATIC ELECTRODES WITH RADIO FREQUENCY IDENTIFICATION, AND METHOD OF USING TRANSPARENT ELECTROSTATIC ELECTRODES

(57) Abstract

First and second transparent electrostatic electrodes (20, 22) are used on a transparent door (10), and are connected to an exciter/receiver unit (30) by conductors (24, 26). These electrodes are respectively used as an exciter antenna plate and an electrostatic reader antenna plate by the exciter/receiver unit (30). A suitable computer security system, using the exciter/receiver unit (30) to provide identifying information of tags as they are read at the exit, can identify items which have not been properly purchased or rented, and could trigger an alarm or block opening of the door. This same principle can likewise be applied to security areas which restrict passage of personnel. A similar arrangement can be provided for use on a transparent windshield or other transparent window of a vehicle, in this case in conjunction with an electrostatic radio frequency identification device which stores vehicle identifying information and transmits it when activated by an exciter/receiver unit (30). This permits automated assembly operations, or automated recording of assembly operations, as the vehicle moves along an assembly line, since its vehicle identifying information is thereby automatically readable. Also, such electrodes can be used on containers for medical use, such as for blood samples which are to be tested, or for testing or inventory of vials of chemicals.



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TRANSPARENT ELECTROSTATIC ELECTRODES WITH RADIO FREQUENCY IDENTIFICATION, AND METHOD OF USING TRANSPARENT ELECTROSTATIC ELECTRODES

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part of prior United States patent application number 09/061,146, filed 16 April 1998 by inventors Ted Geiszler et al, titled "Remotely Powered Electronic Tag with Plural Electrostatic Antennas and Associated Exciter/Reader and Related Method; Radio Frequency Identification Tag System Using Tags Arranged for Coupling to Ground; Radio Frequency Identification Tag Arranged for Magnetically Storing Tag State Information; and Radio Frequency Identification Tag with a Programmable Circuit State" and assigned to Motorola, Inc.

FIELD OF THE INVENTION

The present invention relates generally to portable remotely powered communication devices, and communication devices that employ electrostatic coupling.

More particularly, the invention relates to transparent electrostatic electrodes in combination with radio frequency identification (RFID) tags, and methods of using such transparent electrostatic electrodes.

BACKGROUND OF THE INVENTION

Remotely powered electronic devices and related systems for supplying power to and receiving stored information from such devices are known. These devices are also known as radio frequency identification ("RFID") tags.

Radio frequency identification tags and radio frequency identification tag systems have various uses. These uses include inventory control, livestock control, and sentry systems, for example. Additionally, radio frequency identification tags can be used in electronic article surveillance ("EAS") systems, such as those used at exits where merchandise is sold.

As taught by the aforementioned related patent applications, electrostatic antenna elements can be employed in connection with such radio frequency identification tags. In this regard, an exciter/receiver unit is used to remotely excite a tag unit. Both the receiver unit and the tag unit have electrostatic antenna elements.

It is a problem to provide antenna elements carried by tags which are efficient and relatively small, and yet which can provide a sufficiently strong reception/transmission capability. It is also a problem to deploy such electrostatic antenna elements in such a manner that the tags can be read by an exciter/receiver unit.

It is additionally a problem to use such electrostatic antenna elements on transparent objects or surfaces, such that the electrostatic antenna elements do not interfere with visibility through the transparent objects or surfaces.

In U.S. Patent No. 5,528,314 issued to Nagy, a transparent conductive film vehicle window antenna is disclosed. A similar disclosure by the same inventor is in U.S. Patent No. 5,083,135.

In U.S. Patent No. 5,355,144 issued to Walton, a transparent window antenna for a vehicle is disclosed. In this disclosure, transparent and conductive films are used which are useful in the antenna.

In U.S. Patent No. 4,746,925 issued to Toriyama, a shielded dipole glass antenna with a coaxial feed disclosed. The dipole glass antenna is transparent, and is used for vehicles.

In U.S. Patent No. 5,748,155 issued to Kadunce et al., a glass antenna uses a glass sheet and a transparent electroconductive coating is disclosed.

In U.S. Patent No. 5,688,551 issued to Littman et al., a method of forming an organic electroluminescent display panel is disclosed. This patent teaches transparent conductive electrodes which are used on a transparent substrate.

In U.S. Patent No. 5,670,966 issued to Dishart et al., a glass antenna for a vehicle is disclosed. Transparent electroconductive coatings are used in the antennas.

In U.S. Patent No. 5,606,225 issued to Levine et al., a tetrode arrangement for a color field emission flat panel display with barrier electrodes on the anode plate is disclosed. In this patent transparent conductive electrodes are employed.

In U.S. Patent No. 5,009,928 issued to Hayashi et al., a method for forming a transparent conductive metal oxide film is disclosed. It specifically discloses transparent conductive metal oxide films on glass.

In U.S. Patent No. 4,864,316 issued to Kaoru et al., a vehicle receiving apparatus using a window antenna is disclosed. The window antenna has tuning conductors of transparent conductive film.

In U.S. Patent No. 4,851,734 issued to Hamai et al., a flat fluorescent lamp having transparent electrodes and glass plates is disclosed.

In Inaba et al., U.S. Patent No. 4,849,766, a vehicle window glass antenna is taught which uses transparent conductive film. Another patent to this inventor, U.S. Patent No. 4,768,037 similarly teaches a vehicle window glass antenna which uses transparent conductive film.

None of the references, however, address the problem of providing transparent electrostatic electrodes for use with radio frequency identification tags (RFID), nor methods of using such transparent electrostatic electrodes in combination with such RFID devices that are capacitively couplable to another device.

Further, none of the references disclose electrostatic RFID devices having transparent electrodes. Additionally, none of the references address the problems of using transparent electrostatic electrodes with RFID devices on exit doors where merchandise is sold, for example, or on medical containers such as containers for blood or other bodily fluid samples. Also, none of the references address the problems of using transparent electrostatic electrodes with RFID devices on windshields of vehicles.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is a front elevational view of transparent electrostatic electrodes used on a transparent door in conjunction with an electrostatic radio frequency identification device, according to the present invention.

FIG. 1B is a front elevational view of another embodiment of a transparent electrostatic electrode used on a transparent door in conjunction with an electrostatic radio frequency identification device, according to the present invention.

FIG. 2 is a front elevational view of a device similar to that shown in FIG. 1, and having additional transparent electrostatic electrodes.

FIG. 3A is a side sectional view of a transparent electrostatic electrode according to FIGS. 1 and 2, disposed on a transparent substrate.

FIG. 3B is a side sectional view of another embodiment of a transparent electrostatic electrode similar to FIG. 3A, disposed on a transparent substrate.

FIG. 4 is a top elevational view of a transparent electrostatic electrode used on a transparent windshield in conjunction with an electrostatic radio frequency identification device, according to the present invention.

FIG. 5 is a top elevational view of transparent electrostatic electrodes used on a transparent windshield similar to that shown in FIG. 4.

FIG. 6 is a top elevational view of a transparent electrostatic electrodes used on a transparent windshield similar to that shown in FIG. 4, wherein the transparent electrostatic electrode covers nearly the entire windshield surface.

FIG. 7A is a schematic illustration of an exciter/receiver device having a pair of electrostatic exciter antenna plates and an electrostatic reader antenna plate.

FIG. 7B is a schematic illustration of an exciter receiver device having a single exciter antenna plate, an electrostatic reader antenna plate, and a ground connection.

FIG. 8A is a schematic illustration of a communication device having a pair of electrostatic device antenna plates, for communicating with the exciter/receiver device of FIG. 7A.

FIG. 8B is a schematic illustration of a communication device having a single electrostatic device antenna plate plus a ground connection or coupling for communicating with the receiver device of FIG. 7B.

FIG. 9 is a front elevational view of a transparent electrostatic electrode with a communication device similar to that shown in FIG. 8, used on a transparent cylindrical container.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

From the foregoing, it is seen that it is a problem in the art to provide a device, arrangement, and/or method meeting the above requirements. According to the present invention, a device is provided which meets the aforementioned requirements and needs in the prior art. Specifically, the device

according to the present invention provides transparent electrostatic electrodes for use with radio frequency identification (RFID) tags, and methods of using such transparent electrostatic electrodes in combination with such RFID devices.

An advantage of the present invention is that it permits the transparent electrostatic electrodes to be placed away from the transmitter/receiver so as to reduce noise, and to provide for a larger antenna surface. The transparent electrostatic electrodes, being transparent, can be applied on locations which otherwise could not be used, such as windshields of cars, glass doors, and transparent bottles or vials used for medical or laboratory purposes.

The present invention permits use of transparent electrostatic electrodes with electrostatic RFID devices on exit doors where merchandise is sold, for example, or on medical containers such as containers for blood or other bodily fluid samples. Additionally, the present invention permits use of transparent electrostatic electrodes with RFID devices on windshields of vehicles.

In the system according to the present invention, the tag preferably comprises two electrodes. One of the two electrodes may be a connection to ground. An advantage of the present invention is to provide transparent electrostatic electrodes for use in combination with electrostatic radio frequency identification devices.

Another advantage of the present invention is to provide a transparent electrostatic electrodes for use with inventory processes or manufacturing processes.

A further advantage of the present invention is to provide a transparent electrostatic electrodes for use with RFID security devices to detect unauthorized removal of protected articles.

These and other advantages according to the present invention are accomplished by provision of transparent electrostatic electrodes in combination with an electrostatic radio frequency identification device. Other advantages of the present invention will be more readily apparent from the following detailed description when read in conjunction with the accompanying drawings.

As shown in FIG. 1A, first and second transparent electrostatic electrodes 20 and 22 are used on a transparent door 10, and are connected to an exciter/receiver unit 30 by respective conductors 24 and 26. The first and second transparent electrostatic electrodes 20 and 22 are respectively used as an

exciter antenna plate and an electrostatic reader antenna plate with the exciter/receiver unit 30.

A receive antenna RA is also disposed on the transparent door 10, and is electrically connected to the exciter/receiver unit 30. The receive antenna RA can also be formed as a transparent electrostatic electrode, or can be non-transparent.

The conductors 24 and 26 can be conductive wires, or can be formed in the same manner as the first and second transparent electrostatic electrodes 20 and 22 as discussed hereunder.

In an area where an exit is present, it is useful to detect passage of particular persons, merchandise, or other articles to be secured, for example. Accordingly radio frequency identification (RFID) tags can be provided on specific articles to be detected by the exciter/receiver unit 30. Such tags are electrostatically-readable. Such radio frequency identification tags contain specific information to be transmitted, as discussed in the aforementioned co-pending U.S. patent applications.

An advantage of the present invention is that it permits electrostatic electrodes to be placed away from a transmitter/receiver so as to reduce noise, and to provide for a larger antenna surface. Such electrostatic electrodes, being transparent, can be applied on locations which otherwise could not be used, such as windshields of cars, glass doors, and transparent bottles or vials used for medical or laboratory purposes. It is noted that the term "transparent" as used herein is intended to encompass "translucent" as well. That is, the electrostatic electrodes according to the invention can be either transparent or translucent.

An additional advantage of such transparent electrostatic electrodes is that they do not detract from the appearance of objects they are placed upon, and instead permit such objects to have an aesthetically pleasing appearance since the electrostatic electrodes are "invisible" or not apparent. This can be an important concern, too, where the electrostatic electrodes are used for access control or inventory control, where it may be desirable that the location of the electrodes be inconspicuous for security purposes.

Thus, for example, merchandise to be secured in a videotape rental outlet includes videotapes, and tagged videotapes bearing radio frequency identification tags can be specifically detected and identified in this way. A

suitable computer security system, using the exciter/receiver unit 30 to provide identifying information of tags as they are read at the exit, can identify videotapes which not have been properly rented out, and could trigger an alarm or block opening of the door. This same principle can likewise be applied to security areas which restrict passage of personnel, whereby personnel wearing permitted tags are granted entry, and personnel wearing non-permitted tags are barred from access.

FIG. 1B is similar to FIG. 1A, and shows in front elevational view another embodiment of a transparent electrostatic electrode 23. The transparent electrostatic electrode 23 is sufficiently large to cover the entire transparent surface of a door 10, and is connected to an exciter/receiver unit 30 by a conductor (unnumbered in FIG. 1B). The unit 30 is connected to a second electrode 27, which need not be transparent. The exciter/receiver unit 30 is grounded in FIG. 1B.

FIG. 2 shows a first pair of transparent electrostatic electrodes 28, 28 and a second pair of transparent electrostatic electrodes 29, 29 applied to the transparent door 10. The first pair of transparent electrostatic electrodes 28, 28 and the second pair of transparent electrostatic electrodes 29, 29 are connected to the exciter/receiver unit 30. The first pair of transparent electrostatic electrodes 28, 28 and the second pair of transparent electrostatic electrodes 29, 29 are respectively used as an exciter antenna plate and an electrostatic reader antenna plate with the exciter/receiver unit 30.

While rectangular antenna shapes are shown for the first and second transparent electrostatic electrodes 20 and 22 and for the first pair of transparent electrostatic electrodes 28, 28 and the second pair of transparent electrostatic electrodes 29, 29, it will be understood that the invention is not limited thereto. For example, non-rectangular shapes can be provided for any of the transparent electrostatic electrodes, and the transparent electrostatic electrodes can be disposed in different locations, without departing from the scope of the invention.

FIG. 3A shows a side sectional view of the transparent electrostatic electrode 20 of FIGS. 1 or 2, disposed on the transparent door 10 which thereby serves as a substrate for the electrode 20. The first and second transparent electrostatic electrodes 20 and 22 can be formed as a conductive film which is applied to the door 10 by an adhesive layer 21 as shown in FIG. 3A, or can be

applied to the door 10 as a conductive coating of transparent conductive material. The conductive film or layer (shown in FIG. 3B as layer 20) can also be sandwiched between two layers of glass as shown in FIG. 3B, which protects the conductive film or layer from wear.

The tags detected by the arrangement shown in FIG. 3A can be relatively small, for example the size of a credit card. Such tags can be formed, for example, similarly to conventional laminated PVC-type access control cards.

Such conductive films and conductive coatings are known in the antenna art. For example, a conductive coating can be baked onto a glass substrate such as the door 10, or can be applied by sputtering, vapor deposition, or other process. If a conductive film is used, it can be formed as a multi-layer film which may include, for example, an Ag layer, and Al layer, and/or a TiO_2 layer. Exemplary conductive coatings could also be indium tin oxide, copper, gold, chromium, iron, nickel, metal oxide, tin, indium, indium oxide, titanium, titanium oxide, zinc oxide, bismuth oxide, zirconium oxide, lead oxide, manganese, zinc-tin alloy, steel, palladium, alkali metals, cadmium, antimony, alloys over a conductive film etc. Further, the adhesive layer 21 of FIG. 3A can be electrically conductive, and can be in the form of a double-sided electrically conductive adhesive tape, for example, Product No. CD9082, available from Specialty Tapes, Racine, Wisconsin. Alternatively, the adhesive can be non-conductive, such as the double-sided electrically non-conductive tape adhesive supplied by 3M® Company, St. Paul, Minnesota as Product No. 9485. Other types of commercial adhesives, tapes, and coatings are also contemplated as being within the scope of the present invention.

It is noted that there are two varieties of tags usable in the present invention, namely a monopole tag and a dipole tag. A monopole tag requires a ground coupling, and a dipole tag requires two electrodes.

FIG. 4 shows a top elevational view a transparent electrostatic electrode 40 used on a transparent windshield 100 of a vehicle 200, in conjunction with an electrostatic radio frequency identification device 32. A wire 42 connects the transparent electrostatic electrode 40 to the electrostatic radio frequency identification device 32. The electrostatic radio frequency identification device 32 stores vehicle identifying information, and transmits it when activated as by an exciter/receiver unit similar to the exciter/receiver unit 30 shown in FIG. 1. This would permit automated assembly operations, or automated recording of

assembly operations, as the vehicle moves along an assembly line, since its vehicle identifying information would be automatically readable.

An example of use of such an arrangement as shown in FIG. 4 would be embedding the vehicle ID number in a portion of the automobile or vehicle which is electrically connected to the electrodes, such as a ROM, so that the electrodes and associated ROM serves to store data pertaining to the automobile or vehicle. Such an arrangement could also be used to store data such as service records, and a history of that automobile or vehicle throughout its life.

While rectangular antenna shapes are shown for the transparent electrostatic electrode 100, it will be understood that the invention is not limited thereto. For example, non-rectangular shapes can be provided for the transparent electrostatic electrode 40, and the transparent electrostatic electrode 40 can be formed in different sizes or disposed in different locations on the windshield 100 or other windows, without departing from the scope of the invention.

FIG. 5 shows in top elevational view transparent electrostatic electrodes 50 and 52 which are applied on the transparent windshield 100 of the vehicle 200 as shown in FIG. 4. The arrangement, sizes, and shapes of the transparent electrostatic electrodes 50 and 52 can be varied as discussed hereinabove, and all such variations are contemplated as being within the scope of the present invention. Similarly to that discussed hereinabove with regard to FIGS. 1-3, such conductive films and conductive coatings are known in the antenna art, and can include conductive coating which is baked onto a glass substrate such as the windshield 100, or can be applied by sputtering, vapor deposition, or other process. If a conductive film is used, it can be formed as a multi-layer film which may include, for example, an Ag layer and a TiO_2 layer. If an adhesive is used, the adhesive can be electrically conductive, and can be in the form of a double-sided electrically conductive adhesive tape, for example, Product No. CD9082, available from Specialty Tapes, Racine, Wisconsin. Alternatively, the adhesive can be non-conductive, such as the double-sided electrically non-conductive tape adhesive supplied by 3M® Company, St. Paul, Minnesota as Product No. 9485. Other types of commercial adhesives, tapes, and coatings are also contemplated as being within the scope of the present invention.

In FIG. 4, the chassis of the vehicle 200 serves as a grounding medium. In FIG. 5, the arrangement shown can serve as a giant dipole since two electrodes 50 and 52 are used.

FIG. 6 is a top elevational view of a transparent electrostatic electrode 60 used on a transparent windshield 100 in a manner similar to that shown in FIGS. 4 and 5. In FIG. 6, the transparent electrostatic electrode 60 covers nearly the entire windshield surface.

The windshield 100 shown in FIGS. 4, 5, and 6 can instead be any window, rather than just a front or rear windshield. The provision of the communication device 32 having an electrostatic device antenna plate T1 on the windshield 100, in addition to facilitating manufacturing operations, would be usable for automated toll booth access, permitting automated payment at tollbooths from an account, without stopping at the tollbooth.

As shown in FIGS. 7A, 7B, 8A and 8B, a contactless capacitive data communication system utilizes an exciter/receiver device 30 and a communication device 32 that electrostatically (i.e., capacitively) communicates information. FIG. 7A is a schematic illustration of the exciter/receiver device 30 having two electrostatic exciter antenna plates E1 and E2, and an electrostatic reader antenna plate R1.

The pair of antenna plates E1 and E2 operate as a balanced out of phase pair. It will be recognized that arrays of such antenna plates may also be used, however, for simplicity sake, the description will be limited to two exemplary antenna plates. Alternatively, for example, wire antenna electrostatic elements or comb like structures may be employed instead of antenna plates. In addition, one of the antenna plates may be removed or coupled to ground to form a monopole arrangement as shown in FIG. 7B. FIG. 7B is a schematic illustration of an exciter receiver device 30 having a single exciter antenna plate E1, an electrostatic reader antenna plate R1, and a ground connection functioning as the second exciter antenna connection.

The exciter/receiver device 30 incorporates an excitation source that is modulated (via suitable ASK, FSK or PSK techniques) for use in electrostatic data transmission. The excitation source may be a piezoelectric crystal based excitation source, an inductive excitation source or other suitable excitation source, and oscillates about a frequency of about 125 kilohertz, or any other suitable frequency. The two electrostatic exciter antenna plates E1 and E2 are

arranged for electrostatically transmitting the modulated data to the proximately located communication device 32 shown in FIG. 8A.

While the antenna plate R1 is shown schematically as a single element, it can be composed of multiple elements and/or can also have other shapes. The electrostatic reader antenna plate R1 is apart of a reader portion (not shown) that is connected to a receiver which provides input signals to a detector. An input/output processor may receive signals from the detector to convert the signals for evaluation by the input/output processor to confirm, for example, that data written to the communication device 32 was successful. The reader may also be used for example to read identification data stored therein with the exciter/receiver device 30.

FIG. 8A is a schematic illustration of the communication device 32 having two electrostatic device antenna plates T1 and T2 and a read only memory (not shown), for communicating electrostatically with the exciter/receiver device 30 of FIG. 7A. While only two antenna plates T1 and T2 are shown, it is merely representative of antenna systems, which may include a single or multiple antennas. The communication device 32 may also include an electrostatic data decoder coupled to the first and/or second electrostatic device antenna plates T1 and T2, that decodes electrostatically received data to determine whether data received represents a logic "1" or logic "0".

When the exciter/receiver device 30 of FIG. 7A and the communication device of FIG. 8A (collectively "the contactless capacitive data communication system") are in operation, the system receives electrostatically generated data from the exciter/receiver device 30 and decodes the electrostatically received data to determine whether data received represents a logic "1" or a logic "0." If desired, the system detects a number of received cycles, frequency of received cycles, duration of electrostatically received data or phase of electrostatically received data to determine whether the data received represents a data packet.

In one embodiment, the contactless capacitive data transmission system utilizes demodulated interrupts in RF fields as short gaps in accordance with a predefined gap scheme. The decoder detects a field gap in electrostatically received data, detects data that is to be programmed into an integrated circuit located on the communication device 32, and determines valid cycles within the electrostatically received data. If desired, one of the electrostatic device antenna

plates T2 may be at ground potential to create a monopole receiver as shown in FIG. 8B. FIG. 8B is a schematic illustration of a communication device 32 having a single electrostatic device antenna plate T1 plus a ground connection or coupling for communicating with the receiver device 30 of FIG. 7B.

FIG. 9 is a front elevational view of a pair of transparent electrostatic electrodes 80 and 84 with a tag electronics device 92 (similar to the RFID tag electronics element 53 of FIG. 5), forming a communications device. In this context, the communications device so formed is referred to as a tag.

The pair of transparent electrostatic electrodes 80 and 84 and the tag electronics device 92 are applied on a non-transparent or transparent cylindrical container 70. The communication device 32 of FIG. 9 contains the RFID tag electronics In FIG. 9, a pair of electrostatic electrodes 80 and 84 is shown disposed on a substrate, namely the container 70, and each one of the pair of electrostatic electrodes 80 and 84 is electrically connected to the electronic component, and wherein at least one of the pair of electrostatic electrodes is transparent.

The container 70 can be of a type for scientific or medical use, such as for samples which are to be tested or dispensed. Further, other items or materials can be contained and/or tested, for example salt, flour, pills, tissue paper, chemicals, foodstuffs, or other products. The use of a transparent electrostatic electrode 80 for the antenna permits use of RFID systems on such containers since it does not obstruct the view into the container or any printing disposed on the outside of the container. This can be significant where the contents of the container must be visible or are tested by passage of light therethrough, or where important indicia on the container must not be obstructed. This permits use of a larger antenna than would be the case for an opaque antenna.

The invention being thus described, it will be evident that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention and all such modifications are intended to be included within the scope of the claims.

WHAT IS CLAIMED IS:

CLAIMS

1. A transparent electrode used in conjunction with a first device capacitively couplable to a second device comprising:

a conductive material applied to a non-conductive surface in such a manner that the conductive material is transparent on the non-conductive surface; and

a coupler to electrically couple the conductive material to an electronic component.

2. The transparent electrode in accordance with claim 1 further comprising a non-conductive substrate, wherein the conductive material is disposed onto the non-conductive substrate prior to being applied to the non-conductive surface.

3. The transparent electrode in accordance with claim 2 wherein the conductive material is disposed onto the non-conductive substrate via vapor deposition.

4. The transparent electrode in accordance with claim 2 wherein the conductive material is disposed onto the non-conductive substrate via sputtering.

5. The transparent electrode in accordance with claim 2 wherein an adhesive layer is disposed atop of the conductive material in order to apply the non-conductive substrate to the non-conductive surface.

6. The transparent electrode in accordance with claim 1 wherein the conductive material is baked onto the non-conductive surface.

7. The transparent electrode in accordance with claim 1 wherein the electronic component includes reader electronics.

8. The transparent electrode in accordance with claim 1 wherein the electronic component is an integrated circuit.

9. The transparent electrode in accordance with claim 1 further comprising a protective coating applied atop of the conductive material.

10. The transparent electrode in accordance with claim 1 wherein the conductive material is selected from a group consisting of the following: tin oxide, indium tin oxide, titanium oxide, indium, tin, gold, silver, copper, iron, nickel, chromium and aluminum.

11. The transparent electrode in accordance with claim 1 wherein transparent encompasses translucent and clear.

12. The transparent electrode in accordance with claim 1 wherein the non-conductive substrate is selected from a group consisting of a transparent non-conductive substrate, a translucent non-conductive substrate and a clear non-conductive substrate.

13. A method for creating a transparent electrode used in conjunction with a first device capacitively couplable to a second device comprising:

depositing a conductive material onto a non-conductive surface in such a manner that the conductive material is transparent on the non-conductive surface; and

coupling the conductive material to an electronic component.

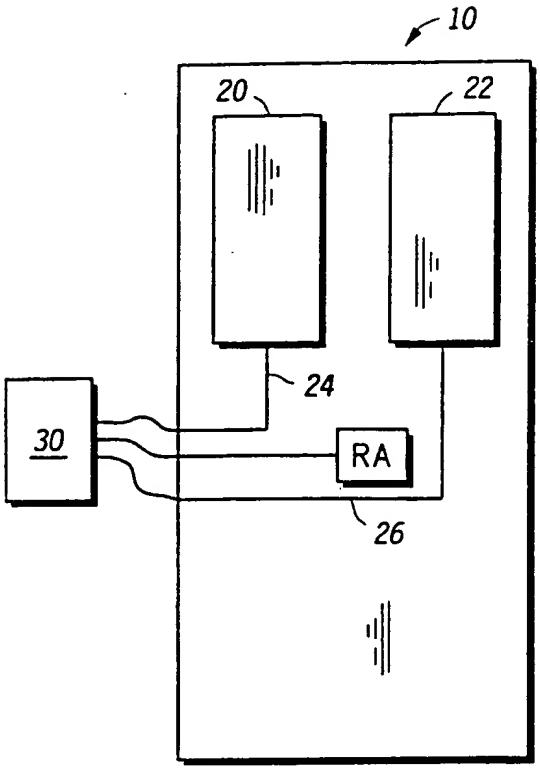

FIG.1A

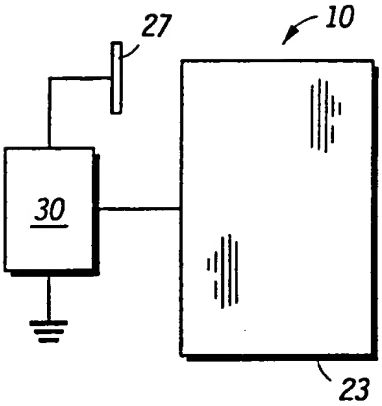

FIG.1B

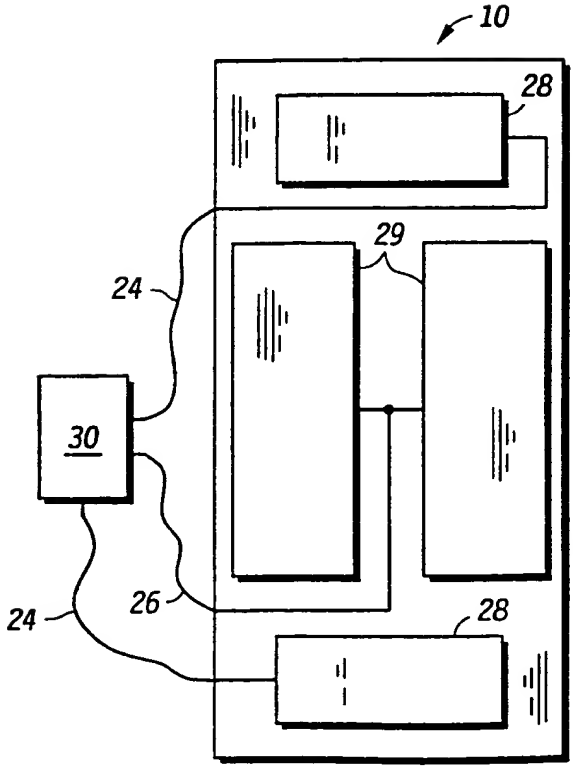

FIG.2

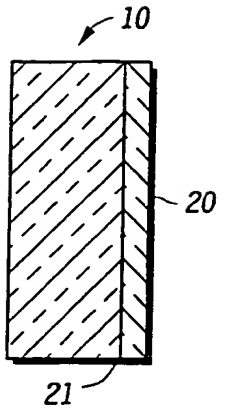

FIG.3A

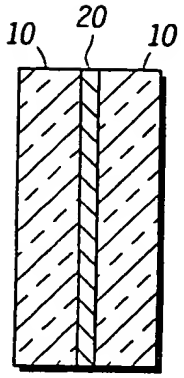

FIG.3B

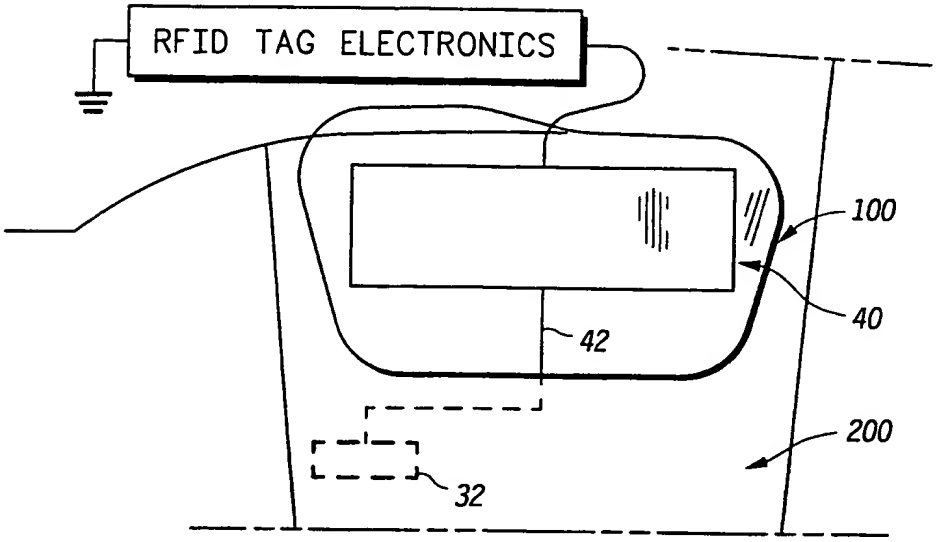

FIG.4

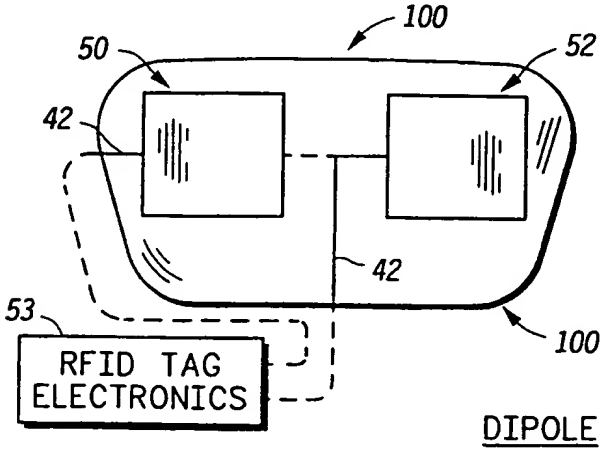

FIG.5

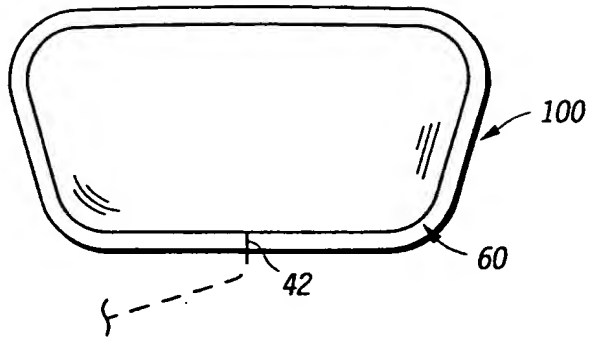

FIG. 6

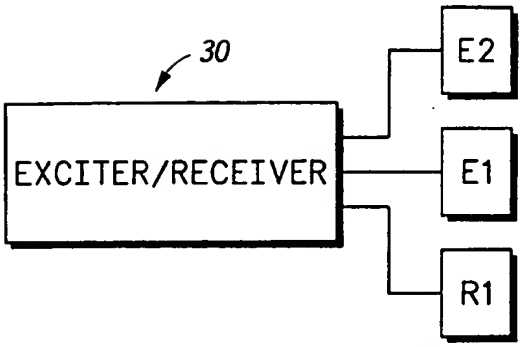

FIG. 7A

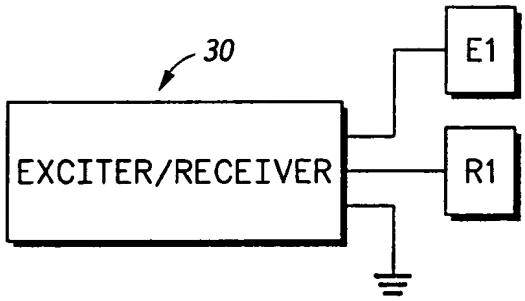

FIG. 7B

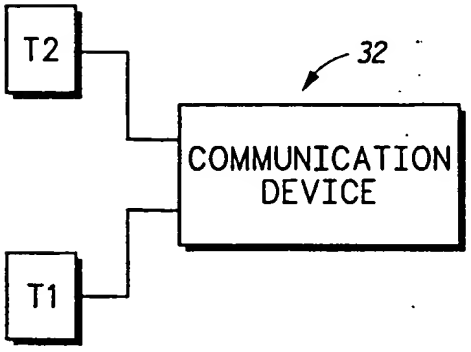

FIG. 8A

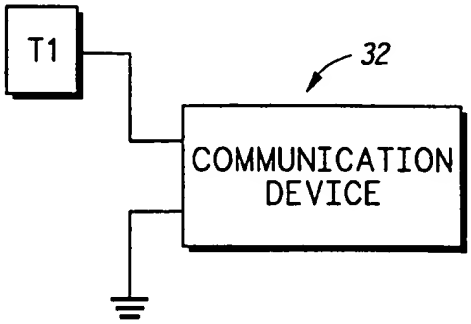

FIG. 8B

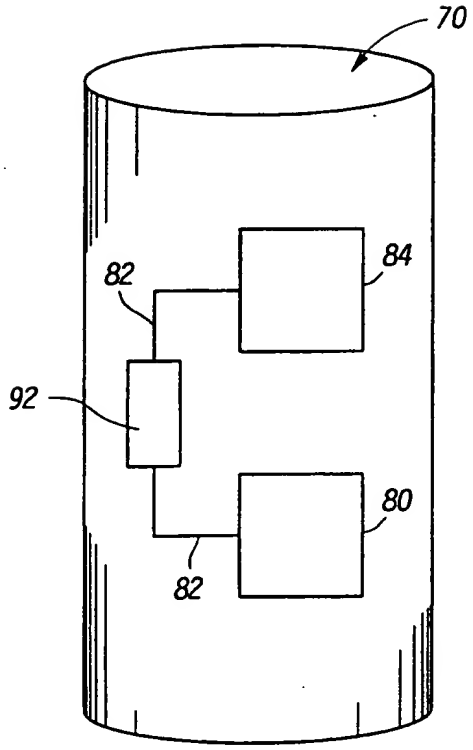

FIG.9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/00201

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : H01Q 1/32
US CL : 174/68.1

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 174/68.1, 174/137A, 174/138R, 174/138G, 361/734, 343/713, 343/906, 257/59, 257/72

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,748,155 A (KADUNCE et al.) 05 May 1998 (05.05.1998), col. 2, lines 59-62, 67,	1-9, 11-13
---	col. 3, lines 1-3, 33-38, col. 4, lines 17-21, 57-65, col. 7, lines 21-23.	---
Y		10
Y	US 5,528,314 A (NAGY et al.) 18 June 1996 (18.06.1996), col. 3, lines 16-24.	10
A	US 6,043,782 A (DISHART et al.) 28 March 2000 (28.03.2000) all	1-13
A	US 5,926,141 A (LINDENMEIER et al.) 20 July 1999 (20.07.1999) all.	1-13
A	US 6,054,961 A (GONG et al.) 25 April 2000 (25.04.2000) all.	1-13
A	US 5,883,599 A (HALL) 16 March 1999 (16.03.1999) all.	1-13
A	US 5,670,966 A (DISHART et al.) 23 September 1997 (23.09.1997) all.	1-13
A	US 5,596,335 A (DISHART et al.) 21 January 1997 (21.01.1997) all.	1-13

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
	06 JUN 2000
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-1341	Authorized officer Kristine Kincaid Telephone No. (703) 308-0640

Form PCT/ISA/210 (second sheet) (July 1998)